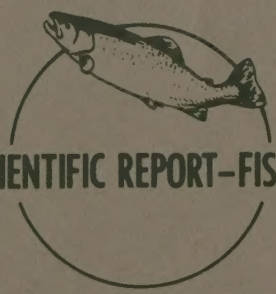
U.S.F.W.S.
SK361
A257f
#520

Bait Shrimp (Penaeus duorarum) in Tampa Bay, Florida--Biology, Fishery Economics, and Changing Habitat

By Carl H. Saloman

LIBRARY
DEC 21 1965
FISH & WILDLIFE SERVICE



SPECIAL SCIENTIFIC REPORT–FISHERIES No. 520

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES

UNITED STATES DEPARTMENT OF THE INTERIOR
Stewart L. Udall, *Secretary*
John A. Carver, Jr., *Under Secretary*
Stanley A. Cain, *Assistant Secretary for Fish and Wildlife and Parks*
FISH AND WILDLIFE SERVICE, Clarence F. Pautzke, *Commissioner*
BUREAU OF COMMERCIAL FISHERIES, Donald L. McKernan, *Director*

Bait Shrimp (Penaeus duorarum) in Tampa Bay, Florida--Biology, Fishery Economics, and Changing Habitat

By

CARL H. SALOMAN

Contribution No. 18, Bureau of Commercial Fisheries
Biological Station, St. Petersburg Beach, Florida

United States Fish and Wildlife Service

Special Scientific Report--Fisheries No. 520

Washington, D.C.
October 1965

CONTENTS

	Page
Introduction	1
Descriptions of area and gear	1
Methods	3
Collection of data	3
Collection of samples	3
Measurements of samples	3
Statistics of the bait shrimp fishery	4
Biological characteristics of bait shrimp	5
Sex ratio and size differences	5
Maturity	7
Length and weight	7
Decline of the bait shrimp fishery	8
Effect of estuarine engineering on shrimping and fishing	8
Literature cited	15

FIGURES

No.		
1.	Bait shrimping areas in Tampa Bay	2
2.	Length measurements of a typical penaeid shrimp (modified from Voss, 1955).	3
3.	Length frequency of 9,145 bait shrimp from Old Tampa Bay and lower Tampa Bay	11
4.	Length frequency of 9,145 bait shrimp from Old Tampa Bay and lower Tampa Bay	12
5.	Total weight of 9,212 bait shrimp from Old Tampa Bay and lower Tampa Bay..	13
6.	Land mass created by dredging and filling through 1963 and some contemplated filling in Boca Ciega Bay	14

TABLES

No.		
1.	Weekly wholesale and retail value and poundage of bait shrimp caught in lower Tampa Bay, October 4, 1961, through April 8, 1962	4
2.	Weekly retail and wholesale value and poundage of bait shrimp caught in Old Tampa Bay, December 4, 1961, through April 8, 1962	5
3.	Weekly fishing effort for bait shrimpers in lower Tampa Bay, October 4, 1961, through April 8, 1962	6
4.	Weekly fishing effort for bait shrimpers in Old Tampa Bay, December 4, 1961, through April 8, 1962	7
5.	Number of bait shrimp and percentage of males in samples purchased weekly for biological analysis in lower Tampa Bay and Old Tampa Bay	8
6.	Carapace length, total length, and total weight of bait shrimp (Penaeus duorarum) from lower Tampa Bay, by sex, October 8, 1961, through April 8, 1962	9
7.	Carapace length, total length, and total weight of bait shrimp (Penaeus duorarum) from Old Tampa Bay, by sex, December 10, 1961, through April 8, 1962	10

Bait Shrimp (Penaeus duorarum) in Tampa Bay, Florida--Biology, Fishery Economics, and Changing Habitat

By

CARL H. SALOMAN, Fishery Biologist (General)
Bureau of Commercial Fisheries Biological Station
St. Petersburg Beach, Florida

ABSTRACT

A bait shrimp survey was made in Tampa Bay, Fla., from October 4, 1961, through April 8, 1962. During this period, the fishery for pink shrimp, Penaeus duorarum, produced 6.2 million individuals, with a retail value of more than $155,000. Most of the shrimp were juveniles, taken from grass flats within Tampa Bay. Females outnumbered males by a narrow margin and were of larger average size than males. Shrimp taken from the two major shrimping areas of Tampa Bay had different sizes. The smallest specimens were caught toward the headwaters of the estuary, in water of relatively low salinity. An average of 8 boats and 12 to 16 men operated the bait shrimp fishery. The catch per unit of effort varied between areas; about 184 more shrimp were retained per boat-hour in lower Tampa Bay than in Old Tampa Bay. Fishing effort and production of bait shrimp in Tampa Bay are declining while the demand is steadily increasing. Dredge-and-fill operations have reduced the amount of available habitat for shrimp and other estuarine-dependent species measurably since 1940.

INTRODUCTION

An annual increase in sport fishing and a demand for live shrimp by sportsmen have created a sizable bait shrimp industry along the Florida coast and throughout the Gulf of Mexico. The importance of shrimp as a bait in southeastern United States has been established by a number of authors. In 1953, the northeast coast of Florida produced over 38 million bait shrimp (de Sylva, 1954). In 1955, the west coast of Florida between Cedar Key and Naples produced over 58 million bait shrimp (Woodburn, Eldred, Clark, Hutton, and Ingle, 1957). Alabama landings exceeded 17,000 pounds (7,700 kg.), or about 850,000 shrimp, in 66 days (Loesch, 1957). Chin (1960) recorded capture of 676,000 pounds (307,000 kg.) of bait shrimp over a 2-year period in Galveston Bay, Tex.

Because of the importance of this industry to commercial and recreational interests in the Tampa Bay area, a survey was made from October 4, 1961, through April 8, 1962, to determine the magnitude of the fishery and related ecological information pertaining to the pink shrimp, Penaeus duorarum.

This report is supplemental to similar bait shrimp surveys in Florida waters; the most significant include those by Tabb (1958), Higman (1952, 1955), Higman and Ellis (1955), Siebenaler (1953), and Idyll (1949, 1950). Costello and Allen (in press) identified the principal areas where bait shrimp are caught in southern Florida as Pine Island Sound, the vicinity of Cape Romano, Florida Keys, Florida Bay, Card and Barnes Sounds, and Biscayne Bay south of Miami.

Descriptions of Area and Gear

Tampa Bay is a shallow estuary on the west-central coast of Florida. The Bay has a total shoreline of 212 miles (341 km.) and encompasses an area of 346 square miles (89,620 ha.) (Olson and Morrill, 1955). Some of the shoreline still has mangroves, but land fills and bulkheads have changed its natural configuration measurably in recent years.

Bait shrimping within Tampa Bay is concentrated in two areas (fig. 1). The principal shrimping area is in lower Tampa Bay and Boca Ciega Bay; a smaller fishery exists in Old Tampa Bay.

Shrimp are caught in Tampa Bay from shallow-draft boats equipped with rigid-frame, roller trawls. Woodburn et al. (1957) gave a description of the fishing gear and boats in the bait shrimp industry of the west coast of Florida. Push nets and dip nets also are used but are largely noncommercial. Catch records of bait shrimping with push nets and dip nets are not available, and the take by these methods is insignificant.

In the principal shrimping areas, extensive beds of sea grasses (Thallasia testudinum, Diplanthera wrightii, and Syringodium filiforme) were found with numerous species of algae (Phillips, 1960a).

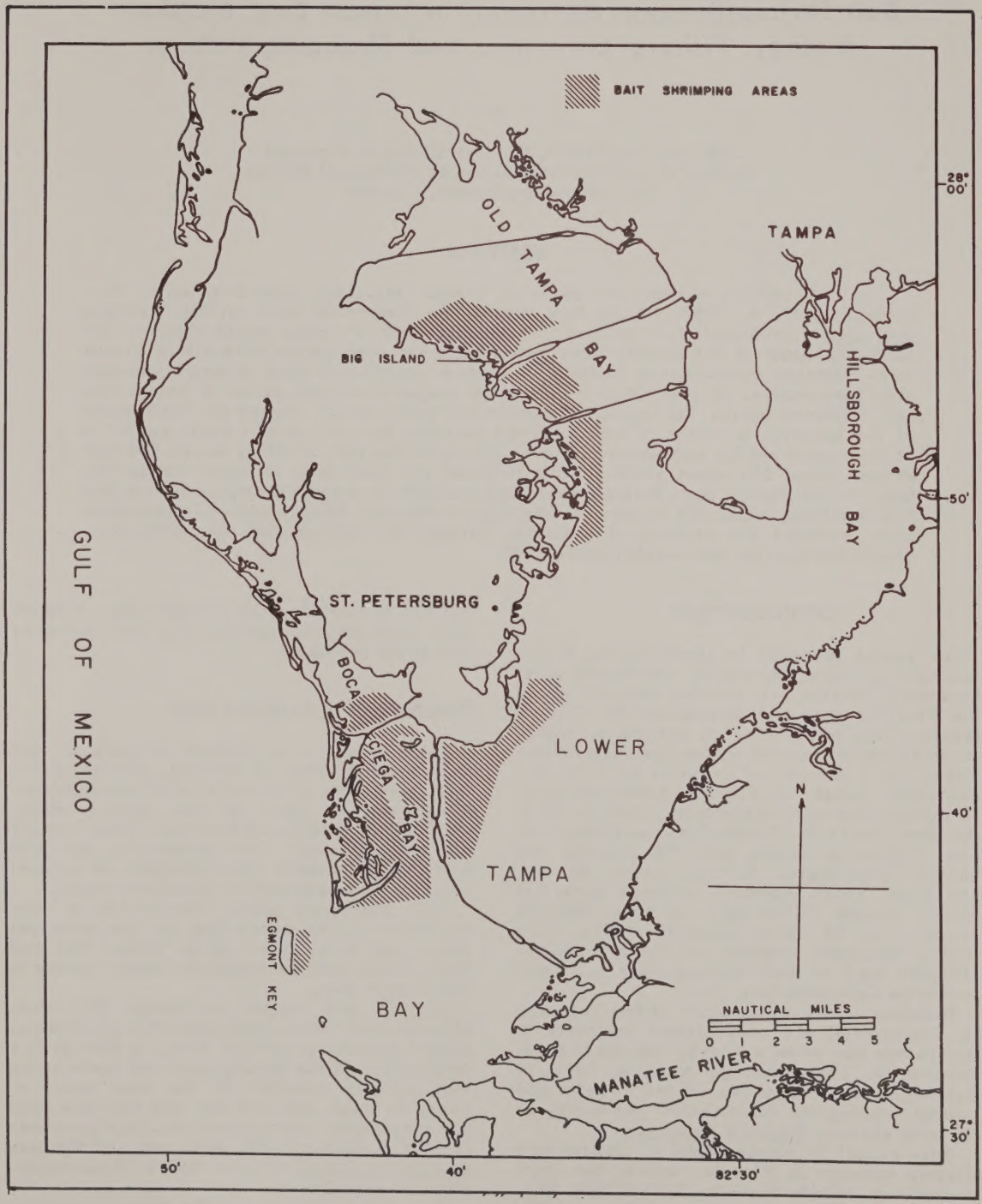


Figure 1.--Bait shrimping areas in Tampa Bay.

METHODS

Collection of Data

To obtain information on areas fished, number of shrimp caught, number of boats, boat-hours, and man-hours, I interviewed all known Tampa Bay bait shrimpers and wholesalers 1 week before the survey began. Thereafter, all bait shrimpers and wholesalers were interviewed weekly. Catch-effort data pertained only to live shrimp and did not include those that died during sorting, handling, and holding. All shrimp were caught at night and usually marketed the following day.

Collection of Samples

Samples for biological analysis were purchased weekly from Tampa Bay shrimpers, wholesalers, and retailers. Although the total number of shrimp purchased varied from week to week, the sample from each supplier contained at least 50 animals. The shrimp were placed immediately on ice in a plastic pan that had perforations to allow the meltwater to pass through. The shrimp were covered with cheesecloth to prevent them from jumping out and then transported to the laboratory in an ice chest. Shrimp from Old Tampa Bay and lower Tampa Bay[1] were kept separate.

Measurements of Samples

The carapace length, the total length, and the total weight were made on each shrimp while it was fresh. The carapace length extends from the posterior portion of the orbital notch to the posterior edge of the carapace (fig. 2). The total length extends from the anterior end of the rostrum to the posterior end of the telson. About one-third of about 50 shrimp were measured and weighed on the day of collection; of these, about 80 percent were still alive at measurement. The others were measured and weighed the following day. All specimens were in excellent condition; a few remained alive after being on ice up to 24 hours. The carapace length was measured to 0.1 mm. with vernier calipers, and the total length to the nearest 0.5 mm. by the specially designed plastic tube (Allen, 1963).

Total weight of the shrimp was taken with a direct-reading, single-pan Metter[2] balance,

[1] Lower Tampa Bay refers to the area near the mouth of Tampa Bay and adjoining Boca Ciega Bay.

[2] Trade names referred to in this publication do not imply endorsement of commercial products.

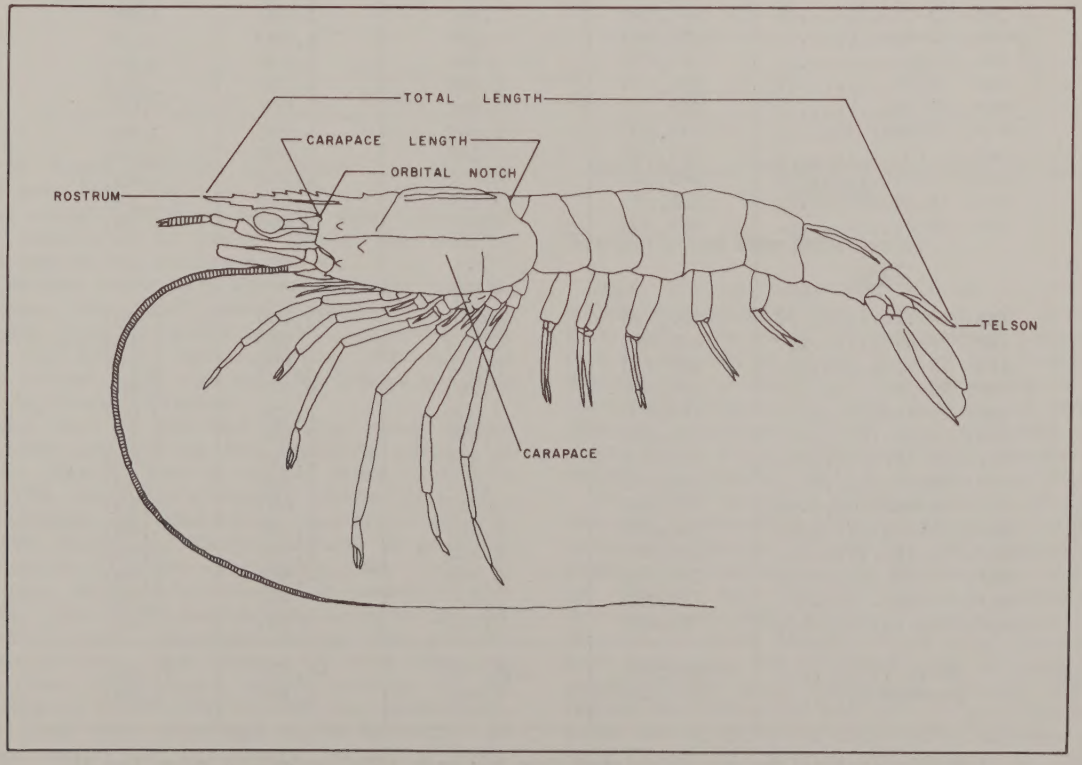


Figure 2.--Length measurements of a typical penaeid shrimp (modified from Voss, 1955).

Type K-7, having an accuracy of ± 0.03 g. (Chin, 1960). Prior to weighing, a specimen was shaken three times to eliminate excess water; its sex was determined; its carapace and total lengths were taken; and the animal was placed in a preweighed paper cup on the balance. After the weighing, each specimen was preserved for subsequent species identification.

STATISTICS OF THE BAIT SHRIMP FISHERY

The catch of bait shrimp from October 4, 1961, through April 8, 1962, was estimated to be more than 6.2 million individuals. Of this number, 5.88 million were caught in lower Tampa Bay (table 1) and 323,700 in Old Tampa Bay (table 2). The total catch of live bait shrimp exceeded 70,000 pounds (31,700 kg.) The wholesale value, based on a price of $8.00 per thousand shrimp, was about $50,000; the retail value, based on an average selling price of $0.30 per dozen, was over $155,000. The period of highest production was October through February. A decline in the take began in March and continued into early April (tables 3 and 4).

The fishing pressure in both areas of Tampa Bay was considered low. It averaged

Table 1.--Weekly wholesale and retail value and poundage of bait shrimp caught in lower Tampa Bay, October 4, 1961, through April 8, 1962

Week of sample	Catch			
	Shrimp caught	Wholesale value @$8.00 per thousand	Retail value @$0.30 per dozen	Total weight (heads on)
1961	Number	Dollars	Dollars	Pounds
Oct. 4-8	155,270	3,880	1,240	[1] 1,770
Oct. 9-15	200,710	5,020	1,610	[1] 2,280
Oct. 16-22	188,780	4,620	1,510	[1] 2,150
Oct. 23-29	237,190	5,930	1,900	2,880
Oct. 30-Nov. 5	210,900	5,270	1,690	2,830
Nov. 6-12	253,730	6,340	1,930	3,350
Nov. 13-19	276,070	6,900	2,200	3,020
Nov. 20-26	238,250	5,960	1,900	2,950
Nov. 27-Dec. 3	253,680	6,340	1,930	2,960
Dec. 4-10	207,170	5,180	1,660	2,040
Dec. 11-17	169,880	4,250	1,370	1,920
Dec. 18-24	126,080	3,150	1,010	1,390
Dec. 25-31	185,760	4,640	1,490	1,700
1962				
Jan. 1-7	261,770	6,540	2,100	[1] 2,980
Jan. 8-14	122,660	3,070	980	1,360
Jan. 15-21	360,720	9,020	2,890	4,370
Jan. 22-28	308,500	7,710	2,470	3,840
Jan. 29-Feb. 4	279,900	7,000	2,250	3,440
Feb. 5-11	233,380	5,830	1,860	2,570
Feb. 12-18	315,600	7,890	2,530	3,540
Feb. 19-25	316,800	7,920	2,540	3,500
Feb. 26-Mar. 4	232,500	5,810	1,860	2,890
Mar. 5-11	169,800	4,250	1,360	1,900
Mar. 12-18	196,350	4,910	1,570	2,000
Mar. 19-25	173,390	4,340	1,380	1,750
Mar. 27-Apr. 1	114,780	2,870	910	1,260
Apr. 2-8	91,400	2,290	730	980
Total	5,881,020	146,930	46,870	67,620
Average	217,820	5,440	1,740	2,500

[1] Estimated total weight calculated from the mean total weight in grams for all shrimp sampled in lower Tampa Bay survey.

Table 2.--Weekly retail and wholesale value and poundage of bait shrimp caught in Old Tampa Bay, December 4, 1961, through April 8, 1962

Week of sample	Catch			
	Shrimp caught	Wholesale value @ $8.00 per thousand	Retail value @ $0.30 per dozen	Total weight (heads on)
1961	Number	Dollars	Dollars	Pounds
Dec. 4-10	8,000	200	64	93
Dec. 11-17	17,500	437	140	276
Dec. 18-24	6,000	150	48	73
1962				
Jan. 1-7	14,000	350	112	153
Jan. 8-14	22,700	568	182	247
Jan. 15-21	21,000	525	168	183
Jan. 22-28	20,000	500	160	311
Jan. 29-Feb. 4	22,000	549	176	196
Feb. 5-11	19,500	487	156	221
Feb. 12-18	26,000	650	208	241
Feb. 19-25	31,000	775	248	268
Feb. 26-Mar. 4	28,500	713	228	309
Mar. 5-11	21,500	538	172	204
Mar. 12-18	16,500	413	132	223
Mar. 19-25	21,000	525	168	216
Mar. 26-Apr. 1	16,500	413	132	189
Apr. 2-8	12,000	300	96	94
Total	323,700	8,093	2,590	3,497
Average	19,040	476	152	206

seven boats per day in lower Tampa Bay and less than one boat per day in Old Tampa Bay. About 184 more shrimp were produced per boat-hour in lower Tampa Bay than in Old Tampa Bay (tables 3 and 4).

Catches consisted almost entirely of pink shrimp. One other penaeid species, Trachypeneus constrictus (Stimpson), occurred rarely and was usually not marketed. This species was sorted from our samples before the pink shrimp were measured.

The size of the bait shrimp catch varied considerably during the sampling period. In lower Tampa Bay it ranged from 91,400 to 360,720 individuals weekly (table 3), and in Old Tampa Bay the range was from 6,000 to 31,000 (table 4). During months of greatest abundance (October-February), the catch of shrimp depended mainly on weather and tides. Cold fronts and accompanying inclement weather were frequent during this period. Furthermore, low tides at this time of the year often drain large portions of the shrimping areas. Fortunately for shrimpers, the tides are generally more favorable at night, when the shrimpers do all of their fishing.

BIOLOGICAL CHARACTERISTICS OF BAIT SHRIMP

Sex Ratio and Size Differences

Pink shrimp examined totaled 11,695 of which 79.3 percent came from lower Tampa Bay. The sex ratio varied among samples and areas, but averaged nearly 1:1; females showed only a slight predominance (table 5). These findings correspond to those of Tabb, Dubrow, and Jones (1962) in Everglades National Park, Fla., and Eldred, Ingle, Woodburn, Hutton, and Jones (1961) in Tampa Bay, Fla.

The mean carapace length of female shrimp was larger than that of males in all except one collection (tables 6 and 7). This inequality confirmed observations by Eldred et al. (1961) on Tampa Bay shrimp. In their samples, females were more abundant than males above 85 mm. in total length. Weymouth, Lindner, and Anderson (1933) found that in Penaeus setiferus the size difference between sexes increased with age and was clearly evident after the majority of individuals reached the total length of 130 mm. Williams (1955) detected no significant difference in size

Table 3.--Weekly fishing effort for bait shrimpers in lower Tampa Bay, October 4, 1961, through April 8, 1962

Week of sample	Shrimp caught	Boats per day[1]	Boat-hours	Man-hours	Shrimp per man-hour	Shrimp per boat-hour
1961	Number	Number	Number	Number	Number	Number
Oct. 4-8	155,270	5.0	278	503	309	559
Oct. 9-15	200,710	5.9	330	583	344	608
Oct. 16-22	188,780	5.6	298	516	366	634
Oct. 23-29	237,190	6.7	361	653	363	657
Oct. 30-Nov. 5	210,900	6.4	353	614	344	597
Nov. 6-12	253,730	7.1	264	360	705	961
Nov. 13-19	276,070	7.3	370	723	382	746
Nov. 20-26	238,250	6.7	238	684	348	1,001
Nov. 27-Dec. 3	253,680	8.0	400	734	346	634
Dec. 4-10	207,170	7.6	389	679	305	533
Dec. 11-17	169,880	5.1	272	503	338	625
Dec. 18-24	126,080	5.1	270	469	269	467
Dec. 25-31	185,760	5.6	304	500	372	611
1962						
Jan. 1-7	261,770	6.3	342	642	408	765
Jan. 8-14	122,660	4.1	220	372	330	558
Jan. 15-21	360,720	9.6	528	864	418	683
Jan. 22-28	308,500	8.7	516	913	338	598
Jan. 29-Feb. 4	279,900	7.1	396	712	393	707
Feb. 5-11	233,380	7.9	422	742	315	553
Feb. 12-18	315,600	9.9	586	1,116	283	539
Feb. 19-25	316,800	8.6	498	868	365	636
Feb. 26-Mar. 4	232,500	8.0	457	809	287	509
Mar. 5-11	169,800	5.7	326	574	296	521
Mar. 12-18	196,350	7.3	389	705	279	505
Mar. 19-25	173,390	6.4	350	644	269	495
Mar. 26-Apr. 1	114,780	4.9	250	448	256	459
Apr. 2-8	91,400	4.0	235	438	209	389
Total	5,881,020	--	9,642	17,368	--	--
Average	217,820	6.7	357	643	339	610

[1] Weekly average.

between sexes when the mean total length was less than 100 mm.

The mean sizes of bait shrimp in Old Tampa Bay were smaller than in lower Tampa Bay (tables 6 and 7). This difference possibly resulted from a difference in salinity. In lower Tampa Bay, the salinity averages 8 to 10 percent higher than in Old Tampa Bay (Saloman, Finucane, and Kelly, 1964). Numerous authors (Burkenroad, 1934; Gunter, 1950, 1961; Gunter, Christmas, and Killabrew, 1964; Williams, 1955; and Tabb et al., 1962) have found a correlation between the size of penaeid shrimp and salinity along the South Atlantic and Gulf coasts of the United States.

Although my assumption is based in large part on the works of these authors, some disagreement exists regarding the effect of salinity on the growth of shrimp. Lindner and Anderson (1956) found that the size of young shrimp was correlated more with locality than salinity and that the apparent relation between size and salinity did not exist for the four stations from which data were analyzed. Under laboratory conditions, Zein-Eldin (1963) determined that postlarval shrimp can survive and grow in a wide range of salinities, and that salinity per se may not play a direct role in growth and survival of postlarval and juvenile shrimp in estuaries.

Table 4.--Weekly fishing effort for bait shrimpers in Old Tampa Bay, December 4, 1961, through April 8, 1962

Week of sample	Shrimp caught	Boats per day[1]	Boat-hours	Man-hours	Shrimp per man-hour	Shrimp per boat hour
1961	Number	Number	Number	Number	Number	Number
Dec. 4-10.....	8,000	0.28	10	30	267	800
Dec. 11-17.....	17,500	.71	40	96	182	438
Dec. 18-24.....	6,000	.28	14	28	214	429
1962						
Jan. 1-7.....	14,000	0.85	42	84	167	333
Jan. 8-14.....	22,700	.85	51	102	223	445
Jan. 15-21.....	21,000	1.28	72	144	146	292
Jan. 22-28.....	20,000	1.14	68	104	192	294
Jan. 29-Feb. 4.....	22,000	.85	45	69	319	489
Feb. 5-11.....	19,500	.71	38	62	315	513
Feb. 12-18.....	26,000	1.00	47	82	317	553
Feb. 19-25.....	31,000	1.14	64	96	323	484
Feb. 26-Mar. 4.....	28,500	1.00	56	88	324	509
Mar. 5-11.....	21,500	.85	48	72	299	448
Mar. 12-18.....	16,500	.57	32	48	344	516
Mar. 19-25.....	21,000	.85	48	72	292	438
Mar. 26-Apr. 1.....	16,500	.85	45	69	239	367
Apr. 2-8.....	12,000	.71	40	64	188	300
Total.....	323,700	--	760	1,310	--	--
Average.....	19,040	0.82	45	77	247	426

[1] Weekly average.

Maturity

Among bait shrimp sampled during this survey, males were more often mature than females, and apparently became mature at a smaller size than females. Eldred (1958) found that male pink shrimp matured at 75 mm. total length and female pink shrimp became impregnated at 91 mm. total length. Cummings (1961) estimated the carapace length of about 22 mm. for female pink shrimp at first sexual maturity. Sexual maturity of males is based on a criterion (both petasma endopods joined) given by Eldred (1958).

Old Tampa Bay appears to be one of the main nursery areas for young pink shrimp in Tampa Bay.

The size of 1,238 pink shrimp caught by Eldred et al. (1961) near Big Island in Old Tampa Bay in 1957 and 1958 had a mean total length of 62 mm. and 56 mm. for those 2 years. These sizes indicate that most of the shrimp were immature and were using the area as a nursery. Most of the female shrimp caught in Old Tampa Bay during the present survey were also young and unimpregnated (81.7 mm. total length). The mean size of the males (79.2 mm.), however, indicated that a higher proportion of males was mature. These shrimp probably reach maturity in the Bay before they migrate into the Gulf of Mexico. Eldred et al. (1961) found that larger shrimp (85-140 mm. total length) migrated from estuarine areas in April through July. They also reported an abundance of pink shrimp caught by commercial shrimp boats offshore from Tampa Bay in the early summer of 1958. I observed commercial boats trawling there in March and April 1963, 1964, and 1965. The catches may have been of shrimp migrating from Tampa Bay and other estuaries in the vicinity, because there was no apparent shrimping offshore from Tampa Bay other than in March and April.

Length and Weight

The bait shrimp from lower Tampa Bay averaged longer (by about 0.5 mm. carapace length and 2.0 mm. total length), and heavier (0.5 g.) than those from Old Tampa Bay (tables 6 and 7). Females were larger and heavier than males in all but one sample--they averaged 0.8 mm. carapace length and 2.0 mm. total length longer and 0.6 g. heavier than males. Females also outnumbered males in the larger size classes (figs. 3-5).

The ranges and means of the carapace length, total length, and total weight taken from each weekly sample should not be considered

Table 5.--Number of bait shrimp and percentage of males in samples purchased weekly for biological analysis in lower Tampa Bay and Old Tampa Bay

Date of Sample	Lower Tampa Bay		Old Tampa Bay	
	Shrimp	Males	Shrimp	Males
1961	Number	Percent	Number	Percent
Oct. 8.....	97	49.5	--	--
Oct. 11....	101	58.4	--	--
Oct. 22....	308	49.0	--	--
Oct. 29....	421	52.0	--	--
Nov. 5.....	422	48.1	--	--
Nov. 12....	403	50.9	--	--
Nov. 19....	527	48.2	--	--
Nov. 26....	405	50.1	--	--
Dec. 3.....	400	50.3	--	--
Dec. 10....	428	48.8	108	54.6
Dec. 17....	430	44.2	95	49.5
Dec. 24....	269	55.0	105	50.5
Dec. 31....	450	51.8	--	--
1962				
Jan. 7.....	--	--	55	43.6
Jan. 14....	310	46.8	143	44.1
Jan. 21....	461	43.0	98	45.9
Jan. 28....	229	54.1	115	60.9
Feb. 4.....	388	48.5	175	54.3
Feb. 11....	391	44.2	153	52.3
Feb. 18....	499	53.3	192	43.2
Feb. 25....	368	49.5	191	54.5
Mar. 4.....	361	51.2	162	51.9
Mar. 11....	382	48.4	100	47.0
Mar. 18....	364	47.8	224	52.7
Mar. 25....	268	52.6	196	49.0
Apr. 1.....	310	49.4	187	47.1
Apr. 8.....	282	50.0	122	54.1
Total....	9,274	--	2,421	--
Average..	356.7	49.4	142.4	50.5

representative of the pink shrimp population in Tampa Bay (tables 6 and 7; figs. 3-5). The smaller specimens were eliminated either by selectivity of the fishing gear or by the fishermen. Shrimp of carapace length smaller than 10.0 mm. and larger than 27.9 mm., total length smaller than 45.0 mm. and larger than 119.5 mm., and weight less than 1.0 g. and more than 13.9 g. are not included in figures 3-5 because of insufficient numbers of specimens. Disposal by fishermen of the smaller shrimp from catches also eliminated most specimens of T. constrictus.

DECLINE OF THE BAIT SHRIMP FISHERY

An almost complete daily sale of marketable bait during the survey was indicated by the demand for live bait shrimp. This demand was created primarily by residents and tourists in Pinellas County, Fla., particularly in the Tampa Bay area. In 1955, almost 15 million bait shrimp were sold in that county (Woodburn et al., 1957). Sales by one dealer in the Boca Ciega Bay area increased from 490,000 to 667,000 shrimp from 1950 to 1955. The increase in retail value for this dealer was $4,425 (Hutton, Eldred, Woodburn, and Ingle, 1956). Although the supply of bait shrimp from Tampa Bay exceeded local demand as recently as 1949 (Idyll, 1949), it now does not. To overcome this shortage, shrimp caught along the periphery of the Gulf of Mexico north of Tampa Bay are now trucked to St. Petersburg and suburbs.

A reduction in the number of bait shrimp caught and of persons and boats in this fishery is evident in both shrimping areas in Tampa Bay. In 1954, about 17 bait shrimp boats fished Boca Ciega Bay from October through May (Hutton et al., 1956). During the present survey, the average number of boats was less than seven per day (table 3).

In 1954, 7 shrimp boats operating full time and 10 fishing part time within Old Tampa Bay landed 4.5 million bait shrimp (Higman and Ellis, 1955). During 1961-62, however, the number of boats actively engaged in shrimping had dwindled to an average of less than one per day, and the catch dropped to 0.32 million shrimp (table 4).

The reduction in fishing effort since 1954 can be attributed to several possible reasons. Shrimping in other areas (mainly the Gulf of Mexico) has produced more shrimp of larger size; vessel size has been increased; gear has been improved; and shrimping areas in Old Tampa Bay and Boca Ciega Bay have been reduced in size.

Effect of Estuarine Engineering on Shrimping and Fishing

The only significant alteration of shrimping grounds in Old Tampa Bay between 1954 and 1961 was brought about by the construction of Howard Frankland Bridge and approaches. In this project, about 275 acres (111 ha.) of submerged grass flats were covered with fill material, and much additional acreage was dredged or silted over. The largest reduction in fishing area was in Boca Ciega Bay, where the total water area was reduced by 19.8 percent since 1920 (fig. 6) through the addition of land fill for realty development. Another proposed fill area will add about 1,120 acres (453 ha.) or almost 2 square miles to the total (fig. 6). Hutton et al. (1956) in a report on the ecology of Boca Ciega Bay concluded that 80-90 percent of the bait shrimping area would be eliminated by dredging and filling. If the proposed fill (fig. 6) is completed, this prediction will be reasonably accurate.

Table 6.--Carapace length, total length, and total weight of bait shrimp (Penaeus duorarum) from lower Tampa Bay, by sex, October 8, 1961, through April 8, 1962

Date of sample	Carapace length				Total length				Total weight			
	Females		Males		Females		Males		Females		Males	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
1961	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	G.	G.	G.	G.
Oct. 8.....	19.43	13.0-26.6	19.37	14.5-24.3	81.59	58.5-118.0	83.62	61.5-105.5	--	--	--	--
Oct. 11.....	17.99	12.7-23.9	17.95	14.6-23.3	77.93	56.0-104.5	79.06	63.5-110.0	--	--	--	--
Oct. 22.....	19.26	12.3-30.0	18.36	13.3-26.7	84.68	56.0-127.0	81.01	58.0-114.0	--	--	--	--
Oct. 29.....	19.13	13.8-28.2	17.99	14.0-25.9	84.59	62.0-120.5	80.44	64.5-112.5	6.02	2.13-15.20	5.03	2.31-12.62
Nov. 5.....	18.96	12.4-30.4	19.01	10.5-27.2	85.00	56.0-127.0	85.99	50.0-115.0	6.10	1.63-19.62	6.07	1.12-14.23
Nov. 12.....	18.89	12.2-26.7	18.78	12.1-24.6	84.87	52.0-125.0	84.74	51.6-116.0	6.02	1.66-12.70	5.96	1.62-11.80
Nov. 19.....	18.27	11.4-25.8	17.58	12.3-24.3	80.93	50.0-112.0	78.95	56.5-105.0	5.22	1.19-14.38	4.69	1.52-10.85
Nov. 26.....	19.28	11.9-32.7	18.71	11.8-25.9	85.49	54.0-136.5	83.73	51.0-114.0	5.89	1.35-22.11	5.33	1.14-12.60
Dec. 3.....	19.02	13.7-31.3	17.40	10.6-26.6	86.29	66.5-132.0	82.75	50.0-117.5	5.72	2.29-20.73	4.87	.85-14.03
Dec. 10.....	17.38	12.0-24.8	16.63	10.5-23.8	79.77	57.0-109.0	77.42	50.0-108.0	4.66	1.52-12.24	4.25	1.02-11.01
Dec. 17.....	18.50	11.3-34.9	17.39	12.3-24.9	85.23	52.0-143.5	79.08	58.5-113.0	5.54	1.20-30.37	4.61	1.79-12.48
Dec. 24.....	18.46	14.1-29.6	17.39	13.4-24.2	84.31	65.5-125.5	80.41	64.0-109.0	5.43	2.20-16.90	4.67	2.18-10.78
Dec. 31.....	16.91	10.2-27.0	16.12	10.0-24.9	78.18	48.5-119.5	75.68	47.0-110.0	4.53	0.94-14.52	3.88	.93-11.55
1962												
Jan. 14.....	17.98	13.3-29.2	16.93	11.1-23.2	83.20	63.0-126.0	79.96	55.0-105.5	5.39	2.10-18.37	4.59	1.47-10.06
Jan. 21.....	18.29	12.4-28.1	17.55	11.7-24.1	85.67	60.0-120.0	82.90	57.0-109.0	5.79	1.67-16.43	5.09	1.55-12.33
Jan. 28.....	18.64	13.1-26.3	18.10	13.8-24.9	85.97	63.0-116.0	85.29	64.0-110.0	5.85	2.16-14.78	5.47	2.17-11.05
Feb. 4.....	18.89	13.4-26.9	18.05	12.8-23.6	86.62	61.0-120.0	84.33	60.0-107.5	5.94	1.98-15.84	5.18	1.77-11.06
Feb. 11.....	18.03	13.1-28.2	17.44	13.9-22.4	83.91	64.0-122.0	81.31	64.5-101.0	5.26	1.93-15.29	4.65	2.37- 8.74
Feb. 18.....	18.36	11.7-25.7	17.48	11.2-23.1	83.75	56.0-115.5	81.96	54.5-105.0	5.50	1.53-15.28	4.71	1.25- 9.42
Feb. 25.....	18.00	11.8-26.9	17.45	12.6-22.5	82.48	54.5-118.5	81.61	58.5-100.0	5.26	1.49-14.21	4.76	1.70- 8.60
Mar. 4.....	19.47	13.9-31.8	18.12	12.8-24.6	87.62	63.0-128.0	83.55	59.0-111.0	6.21	2.17-18.93	5.10	1.67-12.86
Mar. 11.....	18.50	12.5-24.4	17.05	12.3-22.2	85.25	58.0-107.5	80.66	57.5-103.0	5.58	1.66-10.75	4.53	1.61- 8.46
Mar. 18.....	17.65	13.1-24.6	16.75	13.1-21.9	81.07	62.0-109.0	79.23	63.0-102.5	4.91	1.86-11.11	4.29	1.94- 8.92
Mar. 25.....	17.52	13.6-23.7	16.61	12.9-21.4	80.35	63.0-106.0	79.06	62.0- 99.0	4.83	1.95-10.99	4.35	2.17- 8.48
Apr. 1.....	17.84	13.3-22.5	17.50	12.7-22.3	83.59	61.5-104.0	80.77	61.5-101.0	5.17	1.99- 9.87	4.80	1.97- 9.28
Apr. 8.....	18.07	14.0-25.3	17.31	12.6-24.4	83.70	62.5-114.0	80.78	62.0- 98.0	5.13	1.98-14.12	4.58	1.95-10.13
Average....	18.41	--	17.65	--	83.54	--	81.32	--	5.48	--	4.85	--
Range.....	--	10.2-34.9	--	10.0-27.2	--	48.5-143.5	--	47.0-117.5	--	0.94-30.37	--	.85-14.23

Table 7.--Carapace length, total length, and total weight of bait shrimp (Penaeus duorarum) from Old Tampa Bay, by sex, December 10, 1961, through April 8, 1962

Date of sample	Carapace length				Total length				Total weight			
	Females		Males		Females		Males		Females		Males	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
1961	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	G.	G.	G.	G.
Dec. 10.....	18.43	12.5-28.6	17.68	12.2-24.7	84.03	55.5-118.0	79.02	57.0-109.0	5.41	1.87-16.40	5.18	1.92-11.12
Dec. 17.....	20.89	16.2-30.2	19.17	12.3-29.6	95.18	77.0-129.0	88.75	60.5-129.0	7.98	3.68-18.34	6.33	1.93-18.43
Dec. 24.....	18.87	14.5-24.6	17.97	14.4-23.2	86.29	68.0-108.0	83.50	68.0-102.5	5.91	2.64-10.37	5.17	2.54- 9.81
1962												
Jan. 7.....	18.26	13.4-26.2	17.96	14.5-25.7	82.58	62.5-113.0	81.87	68.0-111.5	4.97	2.09-12.39	4.94	2.52-11.67
Jan. 14.....	17.82	11.6-25.4	17.67	11.4-24.6	81.00	57.0-107.0	79.94	54.5-105.5	5.03	1.47-13.00	4.88	1.37-11.61
Jan. 21.....	16.21	12.3-23.6	15.77	11.6-23.3	75.55	57.5-106.0	74.56	57.5-106.5	4.09	1.57-10.52	3.79	1.50-10.61
Jan. 28.....	16.30	12.2-27.9	15.32	11.5-23.7	75.27	58.5-119.0	71.57	54.5-106.0	4.00	1.70-16.36	3.22	1.35-10.24
Feb. 4.....	16.67	11.8-26.2	16.26	12.6-21.4	77.30	55.0-116.0	75.93	60.0- 96.0	4.29	1.38-13.61	3.86	1.76- 8.19
Feb. 11.....	18.88	14.2-34.3	16.88	12.8-24.2	86.55	68.0-142.0	79.92	63.0-107.5	5.99	2.52-27.17	4.34	1.78-10.17
Feb. 18.....	17.39	11.8-24.5	16.55	13.3-23.3	79.61	55.0-108.0	77.43	63.0-103.5	4.44	1.43-10.88	3.89	2.08- 9.35
Feb. 25.....	16.74	11.3-25.7	16.33	12.4-23.0	76.25	51.5-110.0	65.32	58.5-107.0	4.21	1.03-12.95	3.96	1.59-10.99
Mar. 4.....	17.91	12.3-26.6	17.89	12.2-25.8	79.53	56.5-113.0	81.74	56.5-114.5	4.95	1.54-13.86	4.88	1.57-13.15
Mar. 11.....	17.79	14.3-25.0	17.46	14.4-22.4	79.81	65.0-105.5	79.17	65.5- 97.5	4.40	2.08-10.14	4.19	2.38- 7.67
Mar. 18.....	19.62	13.8-32.6	18.51	12.8-26.5	89.16	66.5-144.0	84.88	61.5-119.0	6.87	2.37-27.56	5.48	1.86-15.16
Mar. 25.....	17.91	12.3-30.9	16.80	12.8-25.7	81.30	59.5-132.5	78.19	59.5-114.0	5.02	1.67-21.09	4.31	1.67-13.25
Apr. 1.....	18.48	13.2-27.4	17.70	13.4-23.9	83.02	63.5-117.0	81.29	62.0-107.0	5.58	2.14-15.66	4.75	1.97-10.66
Apr. 8.....	16.62	13.5-21.5	15.78	13.2-19.1	75.97	62.0- 96.0	73.05	62.0- 90.0	3.81	1.88- 7.36	3.33	1.96- 5.75
Average....	17.93	--	17.16	--	81.67	--	79.24	--	5.11	--	4.50	--
Range.....	--	11.3-34.3	--	11.4-29.6	--	51.5-144.0	--	54.5-129.0	--	1.03-27.56	--	1.35-18.43

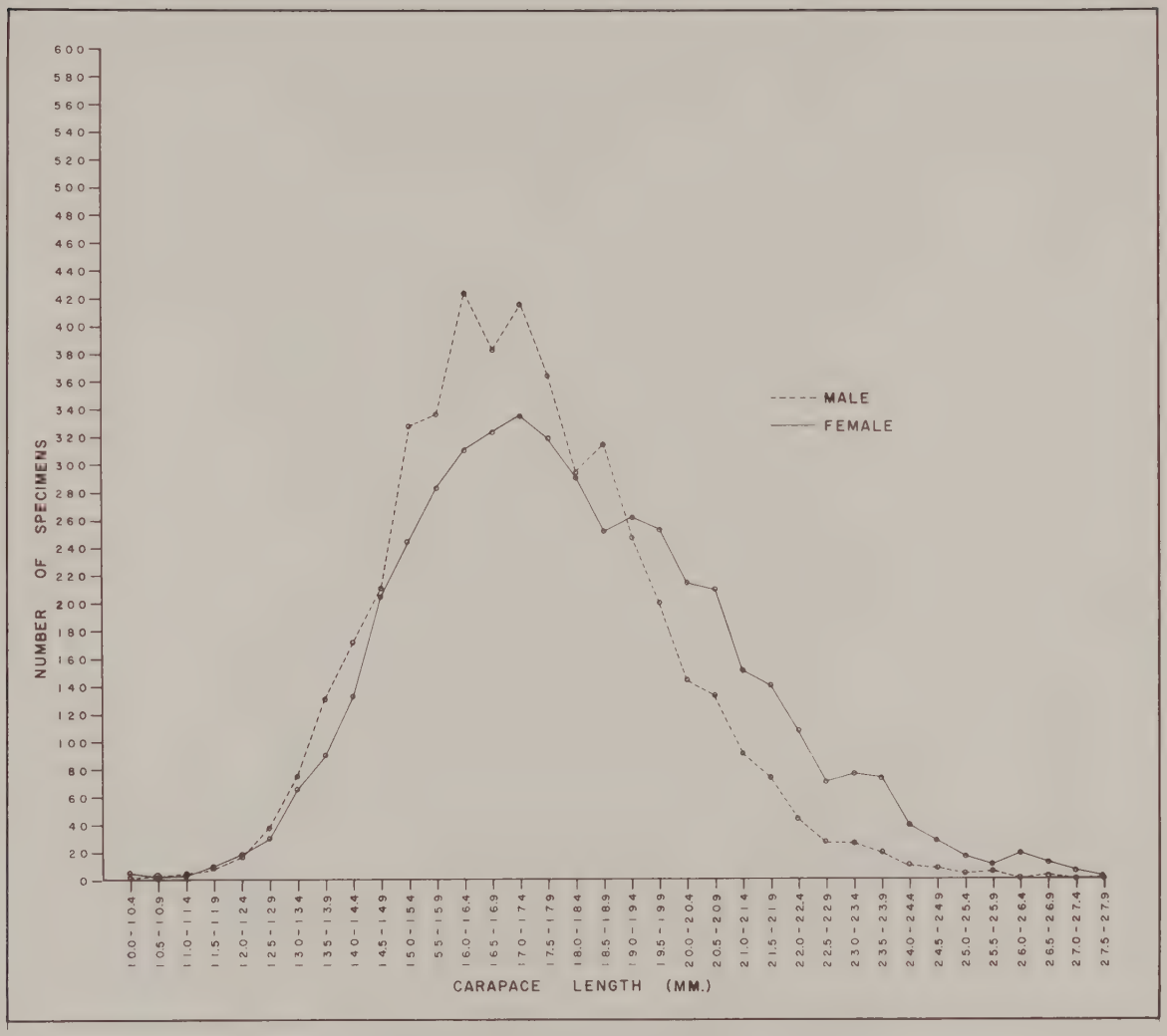


Figure 3.--Length frequency of 9,145 bait shrimp from Old Tampa Bay and lower Tampa Bay.

The continuing destruction of grass beds in the estuaries is eliminating the Tampa Bay nursery for pink shrimp. The necessity of aquatic vegetation (sea grasses and algae) to the survival of small penaeid shrimp has been established by the following authors: Williams (1955), Woodburn et al. (1957), de Sylva (1954), Allen and Inglis (1958), Hutton et al. (1956), Hoese (1960), Phillips (1960b), Woodburn (1959), Hildebrand (1955), and Tabb, Dubrow, and Manning (1962).

The effect of the removal of sea grass from a marine habitat was noted by Stauffer (1937) along the Massachusetts coast. He found that after eelgrass, Zostera marina, disappeared almost all the animals living on or in the grass vanished. About one-third of the characteristic species disappeared entirely; the remaining burrowing species became dominant; and no new species appeared.

Shrimp are not the only fauna of importance intimately associated with estuaries. Power (1962) showed that 1,131 million pounds (513 million kg.), or 89.3 percent of the Gulf of Mexico commercial catch of fish and shellfish consisted of five estuarine-dependent animals (shrimp, crabs, oysters, menhaden, and mullet). Sykes (1964) stated that at least 24 of the important species landed in the Gulf of Mexico fisheries reside in Tampa Bay during part of their early lives. Hutton et al. (1956) also mentioned that Boca Ciega Bay produced commercially 1,186,937 pounds (538,383 kg.) of fish and supported 17 boat dealers and boat repair shops with gross sales of $786,706. The gross sales from over 200 fishing tackle

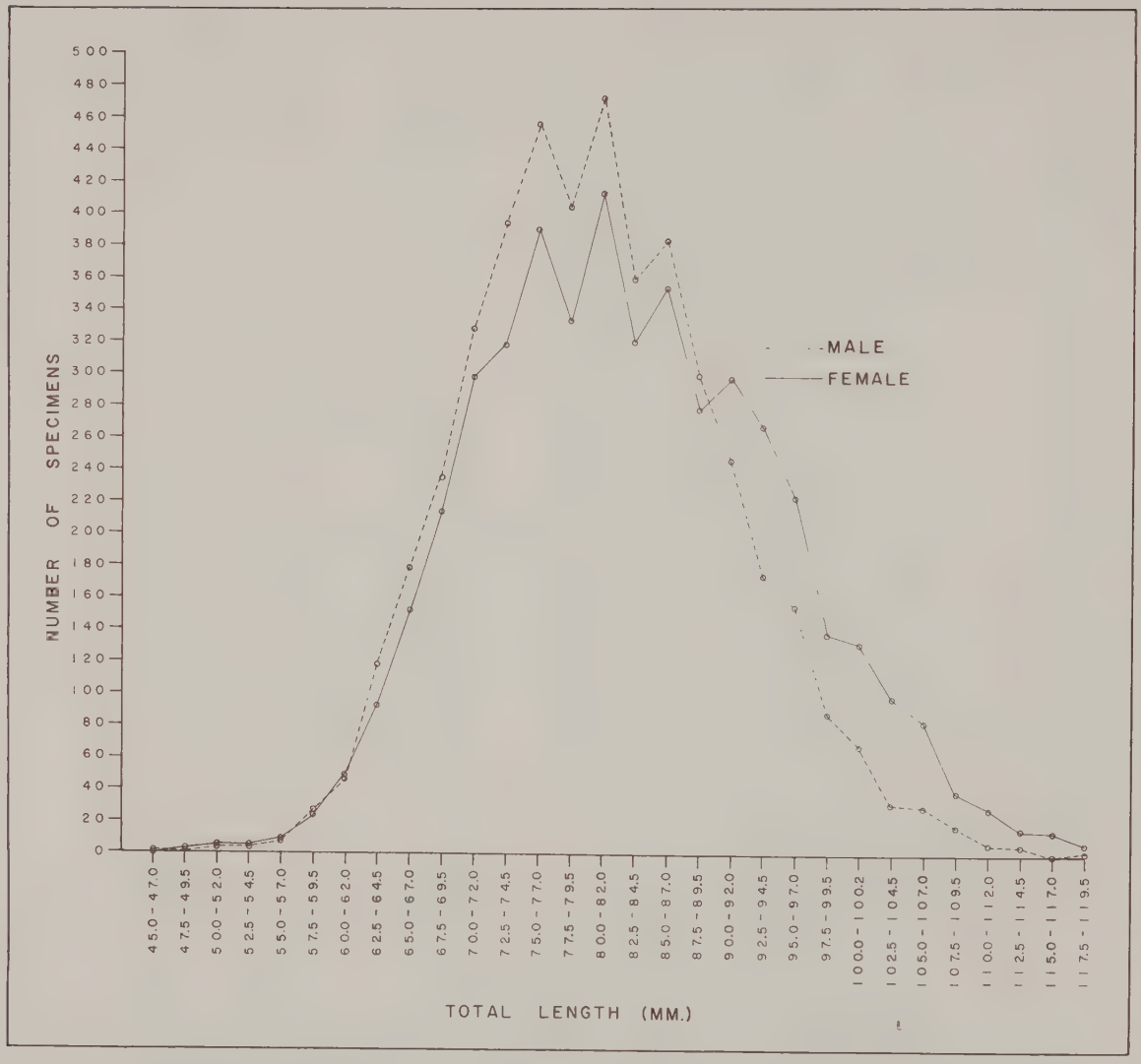


Figure 4.--Length frequency of 9,145 bait shrimp from Old Tampa Bay and lower Tampa Bay.

stores were estimated at $750,000 for 1954. It is obvious, therefore, that the Tampa Bay estuarine system is an important economic asset to Florida and to adjacent States deriving fishery products from Gulf of Mexico commercial fisheries of the Gulf of Mexico.

The increase in population of Florida and a trend toward more outdoor recreation will continue to broaden the demand on water resources, while available water areas are rapidly being altered and reduced. Kidd (1963) stated that the population of Florida in 1960 was almost twice that of 1950 and that by 1970 the population will have increased by another 50 percent. He further stated that the participation of Floridians in outdoor recreation is increasing 65 percent faster than the State's population growth.

Results of the bait shrimp study, the finfish investigation (Sykes and Finucane, in press), and other current biological studies by the Bureau of Commercial Fisheries indicate the need for preventing further loss of estuarine habitats by dredging and filling.

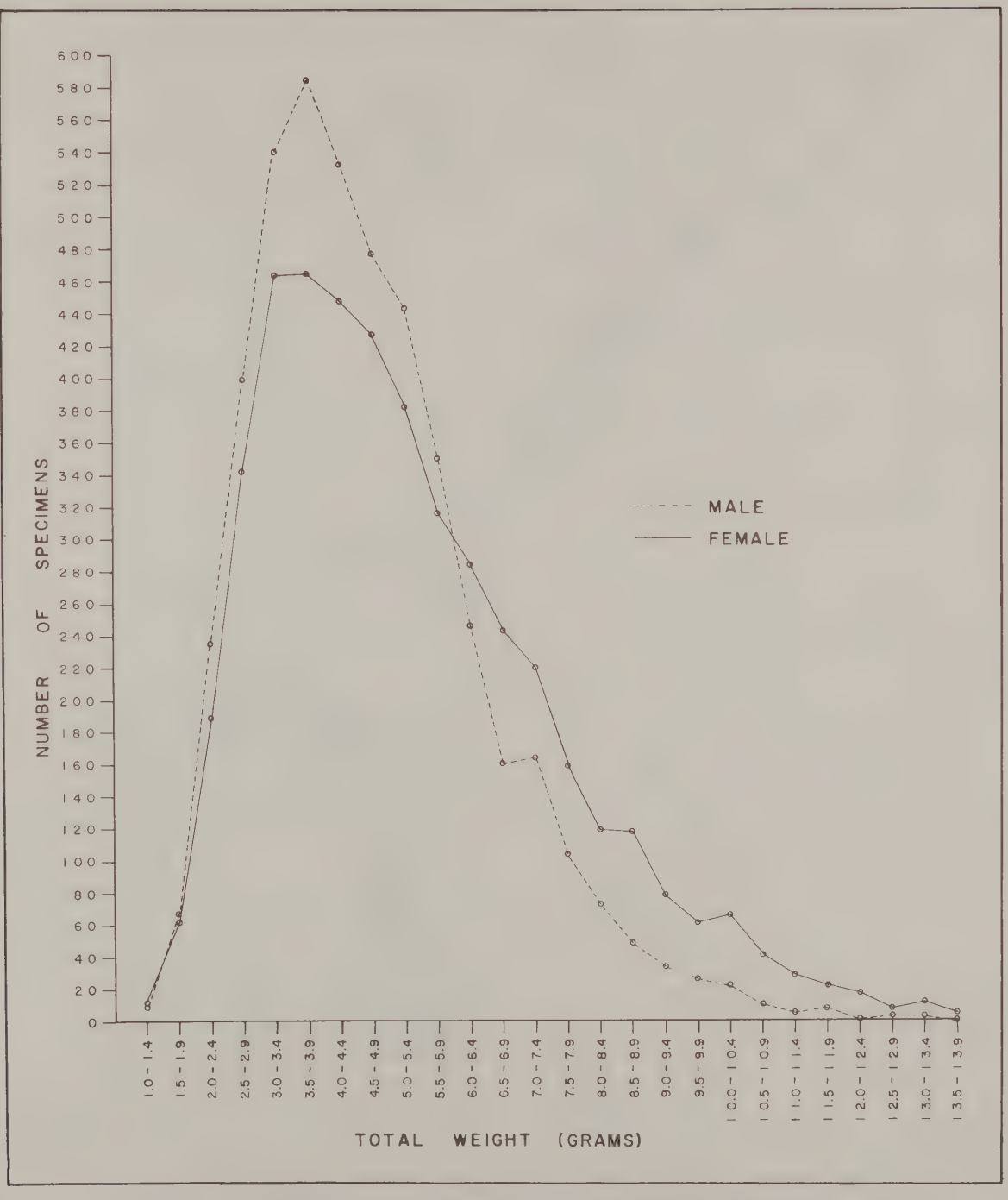


Figure 5.--Total weight of 9,212 bait shrimp from Old Tampa Bay and lower Tampa Bay.

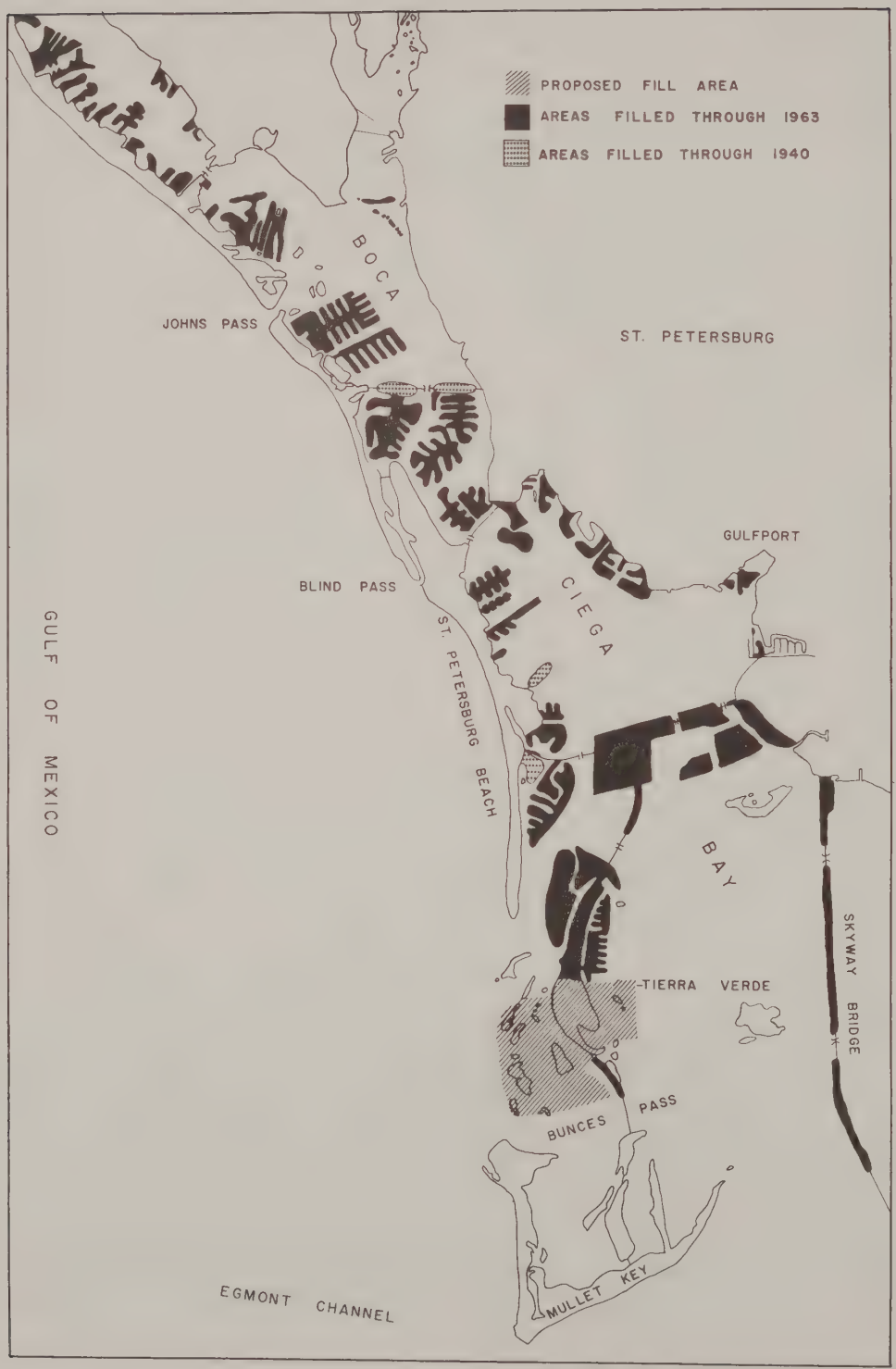


Figure 6.--Land mass created by dredging and filling through 1963 and some contemplated filling in Boca Ciega Bay.

LITERATURE CITED

ALLEN, DONALD M.
1963. A device for measuring live shrimp. U.S. Fish Wildl. Serv., Circ. 161, 92 p.

ALLEN, DONALD M., and ANTHONY INGLIS.
1958. A pushnet for quantitative sampling of shrimp in shallow estuaries. Limnol. Oceanogr. 3(2):239-241.

BURKENROAD, MARTIN D.
1934. The Penaeidae of Louisiana with a discussion of their world relationships. Bull. Amer. Mus. Natur. Hist. 68(2): 61-143.

CHIN, EDWARD.
1960. The bait shrimp fishery of Galveston Bay, Texas. Trans. Amer. Fish. Soc. 89(2):135-141.

COSTELLO, T. J., and DONALD M. ALLEN.
In press. Migrations and geographic distribution of pink shrimp, Penaeus duorarum, of the Tortugas and Sanibel grounds, Florida. U.S. Fish Wildl. Serv., Fish. Bull. 65.

CUMMINGS, WILLIAM C.
1961. Maturation and spawning of the pink shrimp, Penaeus duorarum Burkenroad. Trans. Amer. Fish. Soc. 90(4):462-468.

DE SYLVA, DONALD P.
1954. The live bait shrimp fishery of the northeast coast of Florida. Fla. State Board Conserv., Tech. Ser. 11, 35 p.

ELDRED, BONNIE.
1958. Observations on the structural development of the genitalia and the impregnation of the pink shrimp, Penaeus duorarum Burkenroad. Fla. State Bd. Conserv., Tech. Ser. 23, 26 p.

ELDRED, BONNIE, ROBERT M. INGLE, KENNETH D. WOODBURN, ROBERT F. HUTTON, and HAZEL JONES.
1961. Biological observations on the commercial shrimp, Penaeus duorarum Burkenroad, in Florida waters. Fla. State Bd. Conserv., Tech. Ser. 3, 139 p.

GUNTER, GORDON.
1950. Seasonal population changes and distributions as related to salinity, of certain invertebrates of the Texas coast, including the commercial shrimp. Publ. Inst. Mar. Sci. 1(2):7-51.
1961. Habitat of juvenile shrimp (family Penaeidae). Ecology 42(3):598-600.

GUNTER, GORDON, J. Y. CHRISTMAS, and ROSAMOND KILLABREW.
1964. Some relations of salinity to population distributions of motile estuarine organisms, with special reference to penaeid shrimp. Ecology 45(1):181-185.

HIGMAN, JAMES B.
1952. Preliminary investigation of the live bait shrimp fishery of Florida Bay and the Keys. Fla. State Bd. Conserv., Mar. Lab., Univ. Miami, Mar. Fish. Res. Bull. 52-20, 8 p. [Processed.]
1955. Observations on the live bait shrimp industry of Pasco and Pinellas Counties, Florida. Fla. State Bd. Conserv., Mar. Lab., Univ. Miami, 55-16, 4 p. [Processed.]

HIGMAN, JAMES B., and ROBERT ELLIS.
1955. Investigation of sport and commercial fishery activities in Old Tampa Bay north of Gandy Bridge. Fla. State Bd. Conserv., Mar. Lab., Univ. Miami, 55-20, 5 p. [Processed.]

HILDEBRAND, H. H.
1955. A study of the fauna of the pink shrimp (Penaeus duorarum Burkenroad) grounds in the Gulf of Campeche. Publ. Inst. Mar. Sci. 4(1):169-232.

HOESE, H. D.
1960. Juvenile penaeid shrimp in the shallow Gulf of Mexico. Ecology 41(3):592-593.

HUTTON, ROBERT F., BONNIE ELDRED, KENNETH D. WOODBURN, and ROBERT M. INGLE.
1956. The ecology of Boca Ciega Bay with special reference to dredging and filling operations. Fla. State Bd. Conserv., Tech. Ser. 17, 87 p.

IDYLL, C. P.
1949. Shrimping in Tampa Bay. Report to Fla. State Bd. Conserv., Mar. Lab., Univ. Miami, 49-3. 10 p. [Processed.]
1950. The commercial shrimp industry of Florida. Fla. State Bd. Conserv., Educ. Ser. 6, 33 p.

KIDD, WILLIAM R.
1963. Florida outdoor recreation at the crossroads. Report of the Governor's Committee on Recreational Development, Tallahassee, Fla., 40 p.

LINDNER, MILTON J., and WILLIAM W. ANDERSON.
1956. Growth, migrations, spawning and size distributions of shrimp, Penaeus setiferus. U.S. Fish Wildl. Serv., Fish. Bull. 56:555-645.

LOESCH, HAROLD.
1957. Observations on bait shrimping activities in rivers north of Mobile Bay Causeway. J. Ala. Acad. Sci. 29:36-43.

OLSON, F. C. W., and J. B. MORRILL, JR.
1955. Literature survey of the Tampa Bay area. Armed Serv. Tech. Inform. Agency, AD-81621, pt. 1, 66 p.

PHILLIPS, RONALD C.
1960a. Ecology and distribution of marine algae found in Tampa Bay, Boca Ciega Bay and at Tarpon Springs, Florida. Quart. J. Fla. Acad. Sci. 23(3):222-260.
1960b. Observations on the ecology and distribution of the Florida seagrasses. Fla. State Bd. Conserv., Prof. Pap. Ser. 2, 72 p.

POWER, E. A.
1962. Fishery statistics of the United States, 1960. U.S. Fish Wildl. Serv., Stat. Dig. 53:255-313.

SALOMAN, CARL H., JOHN H. FINUCANE, and JOHN A. KELLY, JR.
1964. Hydrographic observations of Tampa Bay, Florida, and adjacent waters, August 1961 through December 1962. U.S. Fish Wildl. Serv., Data Rep. 4, 6 microfiches (ii +114 p.).

SIEBENALER, J. B.
1953. The Biscayne Bay commercial fishery. Fla. State Bd. Conserv., Tech. Ser. 6, 20 p.

STAUFFER, ROBERT C.
1937. Changes in the invertebrate community of a lagoon after disappearance of the eel grass. Ecology 18(3):427-431.

SYKES, JAMES E.
1964. Requirements of Gulf and south Atlantic estuarine research. Proc. Gulf Carib. Fish. Inst., 16th Annu. Sess.: 113-120.

SYKES, JAMES E., and JOHN H. FINUCANE.
In press. The occurrence in Tampa Bay, Florida, of immature species dominant in Gulf of Mexico commercial fisheries. U.S. Fish Wildl. Serv., Fish. Bull. 65.

TABB, DURBIN C.
1958. Report on the bait shrimp fishery of Biscayne Bay, Miami, Fla. State Bd. Conserv., Mar. Lab., Univ. Miami, 15 p. [Processed.]

TABB, DURBIN C., DAVID L. DUBROW, and ANDREW E. JONES.
1962. Studies on the biology of the pink shrimp, Penaeus duorarum Burkenroad, in Everglades National Park, Florida. Fla. State Bd. Conserv., Tech. Ser. 37, 32 p.

TABB, DURBIN C., DAVID L. DUBROW, and RAYMOND B. MANNING.
1962. The ecology of northern Florida Bay and adjacent estuaries. Fla. State Bd. Conserv., Tech. Ser. 39, 81 p.

VOSS, GILBERT L.
1955. A key to the commercial and potentially commercial shrimp of the family Penaeidae of the western North Atlantic and the Gulf of Mexico. Fla. State Bd. Conserv., Tech. Ser. 14, 23 p.

WEYMOUTH, F. W., MILTON J. LINDNER, and W. W. ANDERSON.
1933. Preliminary report on the life history of the common shrimp, Penaeus setiferus (Linn.) U.S. Bur. Fish., Bull. 48:1-26.

WILLIAMS, AUSTIN B.
1955. A contribution to the life histories of commercial shrimps (Penaeidae) in North Carolina. Bull. Mar. Sci. Gulf Carib. 5(2):116-146.

WOODBURN, KENNETH D.
1959. Arvida - Bird Key fill. Fla. State Bd. Conserv., Mar. Lab., Univ. Miami, 59-46, 6 p. [Processed.]

WOODBURN, KENNETH D., BONNIE ELDRED, EUGENIE CLARK, ROBERT F. HUTTON, and ROBERT M. INGLE.
1957. The live bait shrimp fishery of the west coast of Florida (Cedar Key to Naples). Fla. State Bd. Conserv., Tech. Ser. 21, 33 p.

ZEIN-ELDIN, ZOULA P.
1963. Effect of salinity on growth of postlarval penaeid shrimp. Biol. Bull. 125(1):188-196.

MS. #1479

Created in 1849, the Department of the Interior--a department of conservation--is concerned with the management, conservation, and development of the Nation's water, fish, wildlife, mineral, forest, and park and recreational resources. It also has major responsibilities for Indian and Territorial affairs.

As the Nation's principal conservation agency, the Department works to assure that nonrenewable resources are developed and used wisely, that park and recreational resources are conserved for the future, and that renewable resources make their full contribution to the progress, prosperity, and security of the United States--now and in the future.

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES
WASHINGTON, D.C. 20240

OFFICIAL BUSINESS

Return this sheet to above address, if you do NOT wish to receive this material ☐, or if change of address is needed ☐ (indicate change).

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF THE INTERIOR

Library
BCF Biological Laboratory
P. O. Box 3830
Honolulu, Hawaii 96812
SSR 7